NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)
PROJECT ANNUAL REPORT (DRAFT)

PROJECT TITLE

Moving Forward: Adaptation and Resilience to Climate Change, Drought, and Water Demand in the Urbanizing Southwestern United States and Northern Mexico

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(Research team and full contact information)

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TIME PERIOD ADDRESSED BY REPORT

July 2008-April 2009

I. PRELIMINARY MATERIALS

A Project Abstract *(Limit to one page)*

Spanning three inter-related research domains—regional climate and its impacts, urban water resources management, and stakeholder-based co-production of science and policy—and with a focus on the semi-arid, climatically vulnerable, and the Arizona-Sonora portion of the binational US-Mexico region, this project seeks to better understand (1) how to *institutionalize* the capacity of water managers and civil and emergency preparedness planners to use climate science and information to improve long-range and "adaptive" decisionmaking, (2) how to *regionalize* the efficient development and delivery of relevant and usable "climate outlook" products and services; and (3) how to increase, by integrating climate science into planning processes, the *resilience* of urban border communities to climatic and water-resources uncertainties. Using the collaborative capacity of an experienced, multidisciplinary, and binational research team, our project targets our activities in four highly urbanizing "hotspots" within the region, namely Tucson, Arizona; the "twin" border cities of Nogales, Arizona, and Nogales, Sonora; Hermosillo, the capital of the state of Sonora; and the area surrounding the burgeoning coastal resort-town of Puerto Peñasco, Sonora. For each urban area, our approach involves five principal activities, to: (1) document and assess the community's long-term, water-supply strategies; (2) assess the vulnerability to changes in supply and demand, and the uncertainty of future water supply plans, with particular focus on vulnerabilities at the urban-rural interface; (3) develop case studies to demonstrate opportunities for regionalized adaptive water-management planning; (4) develop, test, and refine a quarterly bilingual and binational climate outlook product with collaborating stakeholder groups; and (5) integrate and synthesize the findings and implications from each of the prior activities, develop final reports and products, and identify next steps for future research and applications activities.
Climate is the key unifying factor for selecting four urban growth hotspots within the monsoon-driven climate regime. The centerpiece of this two-part project (UA and UCAR/NCAR linked projects) is a binational climate outlook product to stimulate new stakeholder-informed climate knowledge to improve long-term, regional adaptive water management, analogous to the RISA products, such as the Western Water Assessment's *Intermountain West Climate Summary* or CLIMAS's *Southwest Climate Outlook.* The need for such a product has been articulated by two workshops, one in Hermosillo (January 2006) and at the Monsoon Regional Climate Applications workshop, also in 2006. An early version of this product has been developed by our research team and SMN (Mexico's National Meteorological Service).

B Objective of Research Project *(Limit to one paragraph)*

Key objectives of this project are to *institutionalize* effective use of climate information and climate science to promote adaptive water resources management in the long term; and to *regionalize* the production and dissemination of climate information and climate science in recognition of shared regional climate, economic interconnectedness, and similar rapid growth profiles in the Arizona-Sonora border region. We are moving beyond the limited amount of regional climate information currently available to specific sectors including urban water managers civil preparedness planners, and transboundary and regional water planners on both sides of the border to develop a technologically sophisticated binational climate product that relies upon state-of-the-art climate forecasts and models, Through the research team comprising UA, NCAR, NOAA, IMTA, COLSON, and in cooperation with SMN in Mexico and Tucson Water, we are refining, and field-testing a new, quarterly climate product thereby promoting sophisticated use and effective application of climate information. The binational climate outlook being developed builds upon the insights and input gathered in workshops with our collaborating stakeholders to incorporate essential features into the final product. Our team is providing training to collaborating stakeholders to facilitate sophisticated use and understanding of regional climate information. We also are building institutional capacity for utilizing climate science for water supply planning as well as new processes for regional cooperation and expertise-sharing on both sides of the border.

C Approach (including methodological framework, models used, theory developed and tested, project monitoring and evaluation criteria) include a description of the key beneficiaries of the anticipated findings of this project (e.g., decisionmakers in a particular sector/level of government, researchers, private sector, science and resource management agencies) *(Limit to one page)*

The methodological framework for the project is to: a) document and assess long-term water supply strategies in the urban study sites; b) conduct vulnerability assessments in the four urban study sites; c) assess institutional and adaptive planning capacity in each of the sites; and d) focus on the co-production of climatic information for use in the binational climate outlook product to influence regional adaptive water management. The data gathered in the first phase of the research serves as the basis for three case studies being developed in this project, including for Tucson-Hermosillo; Ambos Nogales; and Puerto Peñasco. To complete the first phase of our research, we are relying on three principal methods: database construction, semi-structured intensive interviews, and stakeholder workshops. We are using census data and government economic data to construct a database to analyze demographic and economic trends and determine potential impact on climate vulnerability. We are conducting semi-structured interviews with water managers, preparedness planners, urban and rural water users, and other stakeholders to identify institutional changes, to indentify water management and augmentation planning practices, to ascertain costs associated with recent drought in the region, to identify available sources of climate information and science, and to identify principal elements of vulnerability in the four urban areas. Lastly, we are conducting stakeholder workshops to determine key challenges to achieving goals in 5-, 10-, and 20-year scenarios, to develop institutional maps for climate information flows, to identify available climate information and sources, and to identify adaptive management strategy to meet key challenges. In the stakeholder workshops, we field-test the binational climate outlook prototype, administer a written evaluation survey, and discuss primary areas of vulnerability in terms of short-to-long term water supply and plans for adaptive management . We also facilitate a discussion on institutionalizing the use of the binational climate outlook product in standard long-term planning and current operations of water management and civil preparedness agencies.

Phase I of the project centers on data collection, construction of a database, conducting fieldwork at specific sites, including intensive semi-structured interviews with key stakeholders and meetings with institutional representatives. The project goal is to have draft case studies completed by October 2009. The case studies will include compilation and synthesis of basic socioeconomic and demographic data; assessment of the effectiveness of long-term water supply strategies in the study region; and identification of specific institutional risk factors leading to increased vulnerability to climate-induced water resources variability on the part of urban and coastal area water and emergency managers. We will request stakeholder input on the draft case studies at the end of Phase I of the project. In Phase II of the project, based on the draft case studies, we will work with the engaged stakeholder groups to assess opportunities for regionalized adaptive water management, and where applicable, initiate binational, inter-institutional links towards robust and responsive water management strategies and systems, and assess the utility and effectiveness of the binational climate outlook product to support binational adaptive water management strategies.

The key beneficiaries of the project findings are decisionmakers in southern Arizona and northwest Mexico including: federal, state and municipal water managers and agencies and emergency preparedness and disaster planning professionals, as well as the climate and water research community itself. The general public will also benefit through our sustained collaboration with real-world decision-makers and water managers to be better able to meet society's future water supply needs, particularly in the four major urban areas targeted in our study. Additionally, the scientific community will benefit from our project's results in innovative, transboundary processes for engaging a diverse set of stakeholder groups to work on institutional innovations in the utilization of climate science, and in the development of a prototype model for co-production of stakeholder-informed science. NOAA will benefit by advancing new ways to institutionalize climate information and science in long-term planning, mitigation, and adaptation strategies.

D Description of any matching funds/activities used in this project *(Limit to one paragraph)*

The NOAA-SARP Moving Forward grant has permitted the team to build synergies and successfully leverage a total of $10.5 million in funds through various other grants and fellowships. Please see section V for a list of leveraged funds.

II. ACCOMPLISHMENTS

A. Brief discussion of project timeline and tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken, or analysis and/or evaluation undertaken, workshops held, training or other capacity building activities implemented. *(This can be submitted in bullet form – limit to two pages)*

Project Timeline and Tasks Accomplished:

July 1, 2008: Funding began on project

July 2-August 15: Recruitment and hiring of three graduate research assistants for project

August 16-September 25: Planning first workshop

September 26, 2008: First major NOAA-SARP "Moving Forward" project workshop held at the University of Arizona for binational research team and local stakeholders. Purpose was to launch the research project among the engaged research community and research team, and to coordinate a workplan for Phase I of the project.

Mid-September-November 6:

Development of required Institutional Review Board (IRB) application to receive University of Arizona approval to conduct the proposed research involving human subjects

Project PI's began monthly meetings to discuss workplan and research progress

Begin development of socioeconomic & demographic database for the four urban study sites

Conduct review of academic literature, study reports, and available institutional data on the four urban study sites; compile into data files for ongoing reference

Assist with planning for second major workshop in Hermosillo, Sonora

November 7, 2008:

Second major workshop was held at the Universidad de Sonora in Hermosillo, Sonora. Approximately 65 water managers, climate information managers, and emergency preparedness planners from Hermosillo, Puerto Peñasco, Nogales, Sonora, and Guaymas were in attendance. Focus of workshop was to introduce the Binational Climate Summary/Resumen del Clima de la Frontera (BCS/RCF) product; to discuss specific attributes and potential features of the BCS/RCF; assess its adequacy in meeting identified stakeholder needs; and to administer a written survey and present immediate survey results to the gathered stakeholders. In the evening, the binational research team held a meeting to provide updates on the workplan and coordinate activities for Phase I of the project.

November 8, 2008-March 1, 2009:

Received IRB approval from University of Arizona to conduct proposed human subjects research

Designed and printed poster on leveraged water/climate/growth projects in the Arizona-Sonora region for presentation at IARU meeting in Copenhagen, Denmark on 10-12 March 2009 and for presentation at other international and national meetings

Began fieldwork visits and interviews in Puerto Peñasco (focus on urban water managers, desalination plant planners, and ecological vulnerability assessment in coastal cities), Nogales, Arizona and Nogales, Sonora (focus on municipal water managers), and southeastern Arizona (focus on ranchers and farmers). In addition, continuous fieldwork (funded under the linked and related CLIMAS project) on urban-peri-urban water transfers in Hermosillo and its peri-urban region was conducted between August 2008 and March 2009.

Presentation of NOAA-SARP Project at Arizona-Mexico Commission biannual meeting to the AZMC Water Committee

Began development of extensive matrix to guide development of case studies in multiple study sites to ensure consistency across research team

II. ACCOMPLISHMENTS, CONTINUED

March 5-6, 2009:
Presentation on NOAA-SARP "Moving Forward" Project at workshop on Climate-Related Water Constraints and Their Implications for Relations Across North American Boundaries, hosted by the Climate and Hydrology Academic Network for Governance and the
Environment (CHANGE), Mexico, D.F. Workshop included 23 researchers and agency specialists from Canada, the United States, and Mexico to discuss climate, water and policy issues and challenges in North America's transboundary regions
March 7-April 30, 2009:
Finalized plans for July 22-23, 2009 workshop in Cuernavaca, Morelos, Mexico with key stakeholders from the Servicio Meteorológico Nacional (Mexico's National Weather Service), the Instituto Mexicano de Tecnología del Agua (IMTA) (research arm of federal water management agency, and CONAGUA (Comisión Nacional del Agua, federal water management agency).
Continued field work visits and interviews in southeastern Arizona (farmers and ranchers); in Puerto Peñasco, Sonora (urban water managers, environmental NGOs, ejidos affected by urban water transfers); and Nogales, Arizona and Nogales, Sonora (urban and state water managers); and Hermosillo, Sonora (urban water managers, ejidos in peri-urban areas, irrigation districts, emergency preparedness planners).
Finalized case study matrix template to guide development of case studies across research team

*Please note: Accomplishments of colleagues at NCAR are listed in a separate report submitted by Dr. David Gochis

B. Summary of findings, including their potential or actual implications for efforts to develop applications, methods, and science-based decision support capacity/systems and to foster sustainable resource management and vulnerability reduction. *(Limit to two pages)*

Summary of Findings:

A. **Binational Climate Summary/Resumen del Clima Fronterizo (BCS/RCF**):
— Need for temporally and spatially specific climate information and forecasts is key to improved utilization of such information in planning and management decisions
— Publication in Spanish is key for utilization by stakeholders in Mexico, and thus the bilingual (English/Spanish) publication of BCS/RCF is essential
— Stakeholders would we willing to engage with various BCS/RCF formats, including the current hard copy and internet-based newsletter format, as well as regional video briefings or other potential formats
— Calculated average annual max. temperatures and precipitation 1948-2004 in Hermosillo, Sonora
— Compiled a list of precipitation events in South Sonora

B. **Vulnerability Assessment**
Preliminary research in this and prior projects indicates that the lack of planning and weak institutional frameworks are factors that contribute to higher vulnerability for urban areas in northwest Mexico. Factors contributing to vulnerability in Tucson and southeastern Arizona include lack of new sources of water supply to augment existing sources; urban-agriculture conflicts over future water supply; and challenges in identifying politically and economically feasible adaptive management alternatives. We have evaluated laws and policy documents for emergency preparedness planners and analyzed the organizational structure of the Protección Civil in Sonora.
Research is continuing in Phase I to identify vulnerability indicators in site-specific contexts.

Summary of Findings, continued:

C**. Institutional Capacity and Adaptive Management**

Preliminary research in this and prior projects indicates that climate science products and forecasts are under-utilized by water managers and emergency preparedness planners. Thus, climate science utilization needs to be better institutionalized into the plans and operational activities of water management and disaster planning agencies and institutions.

Highly uneven planning capacity in Tucson and southeastern Arizona in comparison with urban areas in northwest Mexico. The City of Tucson has water supply and drought plans out to 2050 and the State of Arizona has a statewide drought planning strategy. However, to date we have found limited evidence of the existence of water supply and drought plans in Hermosillo, Puerto Peñasco, and Nogales, Sonora, although irrigation districts, for example, do have a planning focus utilizing climate forecasts and projections. We have assessed trends in water management and efficiency from 1995-2007 and calculated a projection of water demand out to 2030 for the city of Hermosillo, Sonora.

We anticipate in Phase II of the study working with water managers and emergency planners to improve planning capacity, especially with respect to utilization of climate science and climate information into management activities; and also we anticipate improved sharing of 'best practices' among the key stakeholders from both sides of the border.

*Please note: Findings from colleagues at NCAR are listed in a separate report submitted by Dr. David Gochis

C. List of any reports, papers, publications or presentations arising from this project; please send any reprints of journal articles as they appear in the literature. Indicate whether a paper is formally reviewed and published. *(No text limit)*

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Wilder, M., R.G. Varady, N. Pineda Pablos, A. Browning-Aiken, **R. E. Díaz** Caravantes, **G. Garfin**. Urban water management, climate science and adaptive capacity in Northern Mexico. In review. *Global Environmental Change*.

Wilder, M. A. Ray, N.Pineda, and R. Díaz. Social and Economic Vulnerability to Climate Change in the U.S.-Mexico Borderlands. For submission to *Journal of Climate Research*.

PRESENTATIONS & PARTICIPATION

Browning-Aiken, A. 2008. The Interplay between Water Institutions and Practices in the U.S.-Mexico Upper San Pedro Basin: Is Economic Development Sustainable Where Transboundary and Regional Policies Conflict? IV International Symposium on Transboundary Waters Management. Thessaloniki, Greece. October 15-18.

Browning-Aiken, A. 2008. Opportunities and Challenges in Arizona for Nonpotable Water Use. Arizona Hydrological Society - 21st Annual Symposium, Flagstaff, AZ Sept. 24-25.

Browning-Aiken, A. 2007 Retos para Implementar Planeación Hidrológica Transfronteriza: Cambios de Políticas Recientes, Regimenes de gestión, y Practicas Institucionales en EEUU y México. WWF4 FT 2.33 Advancing Local Actions in Basins, sub-Basins and Aquifers through Comprehensive IWRM Learning and Global Networks. 4th World Mater forum, Mexico City, Mexico.

Browning-Aiken, A. 2007. A River Running in the Desert: Lessons for IWRM from the San Pedro HELP Basin on the U.S.-Mexico Border. HELP Southern Symposium: HELP in Action --Local Solutions to Global Water Problems--Lessons from the South. South Africa, Gauteng. November 4-9.

Browning, A., D. Goodrich, **R. Varady**, and H. Richter. 2007. Lessons for integrated water resources management from the San Pedro HELP Basin on the U.S.-Mexico border. Eos Trans. AGU, 88(52), Fall Mtg. Supplement, Abstract H21F-0809 (Poster Presentation, Fall AGU Meeting, San Francisco, CA, 10-14 Dec.).

Coles, A.R., Scott, C.A., and Garfin, G.M. 2009. Weather, climate, and water: an assessment of risk, vulnerability, and communication on the U.S.-Mexico border. Annual Meeting of the American Meteorological Society. Phoenix, Arizona. January 11-15.

Coles, A.R., and McEvoy, J. 2008. Water resources and vulnerability to climate change in Arizona and Sonora. Joint Inter-American Institute – National Center for Atmospheric Research Advanced Study Program Colloquium, "Seasonality and Water Resources in the Western Hemisphere. Mendoza, Argentina. October 6-17.

Coles, A.R., Scott, C.A., and Garfin, G.M. 2008. Information flows and policy: Use of climate diagnostics and cyclone prediction for adaptive water-resources management under climatic uncertainty in western North America." American Institute of Professional Geologists 45th Annual Meeting, Arizona Hydrological Society 21st Annual Symposium, and the 3rd International Professional Geologic Conference. Flagstaff, AZ. September 20-24

Díaz, R. 2008. Water for the Environment and Livelihoods: The case Study of Alamos. Annual Meeting of the Association of American Geographers.

Díaz, R. 2007. Water Management, Sustainability and the Challenge of Drought: Geographies of Conservation in Northern México. Annual Meeting of the Association of American Geographers.

Farfán L.M. Update on Border Climate-Related Research. Research Group Meeting On Border Water, Growth And Climate Projects, University of Arizona, Tucson Arizona, September 2008.

Farfán, L.M., R. Romero-Centeno G.B. Raga y J. Zavala-Hidalgo: Landfalling tropical cyclones in the Eastern Pacific. Part I: case studies from 2006 and 2007. Extended Abstract, American Meteorological Society, 28th Conference on Hurricanes and Tropical Meteorology. Orlando FL, April 2008. http://**ams**.confex.com/ams/28Hurricanes/techprogram/paper_138010.htm

Farfán, L.M., D. Pozo, G.B. Raga, R. Romero-Centeno and J. Zavala-Hidalgo: A training course on tropical cyclones over the eastern Pacific Ocean. American Geophysical Union Spring Assembly, Fort Lauderdale Florida, May 2008.

Farfán,L.M. and M.A. Cosio. A weather analysis system for the Baja California peninsula: tropical cyclone season of 2007. American Geophysical Union Spring Assembly, Fort Lauderdale Florida, May 2008.

Flores Felix, F. 2009. "Efectos de la entrada a tierra e los cyclones Norbert y Lowell. Dimensiones Humanas de Ciclones Tropicales" ("Landfall effects of cyclones Norbert and Lowell. Human Dimensions of Tropical Cyclones"), presented at Monsoon Workshop organized by Centro de Ciencias de la Atmósfera, Universidad Nacional Autonoma de México, Acapulco, 13 March 2009.

Garfin, G., 2009. Resumen del Clima de la Frontera/Border Climate Summary and Online Drought Tools. 2009 Border Governors Conference Water Work Table Binational Drought Science Conference, March 26-27, 2009, San Diego, CA (invited talk). http://www.watereducation.org/doc.asp?id=1187

Garfin G., A. Coles, J. McEvoy, K. Sammler, R. Varady, M. Wilder, C.A. Scott, T. Cavazos, A. Ray, D. Gochis, N. Pineda, L. Farfán, and R. Díaz. 2009. Improving Information Flows to Enhance Drought and Climate Change Resilience in Northern Mexico. Poster presented at the NOAA Climate Prediction and Applications Workshop March 24-27, 2009.

Garfin, G., A. Coles , J. McEvoy , K. Sammler , R. Varady , M. Wilder , C. Scott, T. Cavazos, A. Ray, D. Gochis, N. Pineda, L. Farfan, and R. Díaz. 2009. Improving Information Flows to Enhance Drought and Climate Change Resilience in Northern Mexico. NOAA Climate Prediction and Applications Science Workshop. Norman, OK, March 24-27, 2009 (Poster). http://climate.ok.gov/cpasw/presentations.php#G

Garfin, G., R. Varady, A. Ray. 2007. Establishing an ongoing binational U.S.-Mexico border climate diagnostic summary: Developing a prototype and navigating the institutional landscape. Presented at AGU Joint Assembly. Acapulco, Mexico. 23 May.

Goodrich, D., **A. Browning-Aiken, R. G. Varady**, and H. Richter. 2007. Lessons for integrated water resources management from the San Pedro HELP Basin on the U.S.-Mexico border. *Eos Trans. AGU*, 88(52), Fall Mtg. Supplement, Abstract H21F-0809 (Poster Presentation, Fall AGU Meeting, San Francisco, CA, 10-14 Dec.).

Goodrich, D. H. Richter, **R. Varady, A. Browning-Aiken**, and J. Shuttleworth. 2007. The Upper San Pedro Partnership: A case study of successful strategies to connect science to societal needs. Presented at AGU Joint Assembly. Acapulco, Mexico. 25 May.

McEvoy, J. and M. Wilder. 2008. "Avanzando adelante: Adaptación y resiliencia al cambio climático, la sequía y la demanda del agua en los centros urbanizantes del suroeste de EEUU y el noroeste de México." Presented at Arizona-Mexico Commission Fall Plenary Session. Water Committee Meeting. Hermosillo, Sonora, Mexico. December, 8.

Pineda, N. and A. Salazar Adams 2009. "Notas para la historia de los servicios urbanos de agua potable en Sonora." Presented at *Simposio de la Sociedad Sonorense de Historia*, Hermosillo, Sonora, Mexico. February 25.

Pineda, N. y A. Salazar. 2008. Taller: Los flujos de información climática en la costa oeste de América del Norte. Hermosillo, Sonora. 7 de noviembre, organizado conjuntamente con la Universidad de Arizona.

Pineda, N. 2008. XXII Convención anual de la Asociación Nacional de Empresas de Agua (ANEAS). En la presentación del libro Agua Potable en México: Historia reciente, actores, procesos y propuestas. Guadalajara, Jalisco 5, de noviembre de 2008.

Pineda, N.. 2008. II Semana Académica. ITSON. Conferencia. Los enfoques actuales del desarrollo regional. Empalme, Son. 23 de octubre de 2008.

Scott, C.A. 2009. Session chair: Water, Energy, and Global Change (co-sponsored by Water Resources and Energy & Environment Specialty Groups). *Association of American Geographers Annual Meeting*, Las Vegas, 22-27 March 2009.

Scott, C.A. 2009. Panelist, Integrated Water Resources Management, *Best Practices for Stakeholder Engagement in Water Resources Planning*, Water Resources Research Center 2009 Annual Conference, University of Arizona, 17 March 2009.

Scott, C.A. 2009. Flujo de información a tomadores de decisión. *Dimensiones Humanas de Ciclones Tropicales* (Information flows to decision-makers. *Humans Dimensions of Tropical Cyclones*), organized by Centro de Ciencias de la Atmósfera, Universidad Nacional Autonoma de México, Acapulco, 13 March 2009.

Scott, C.A. 2009. The global commodification of wastewater. Panel on *New Trends in Regulation,* Symposium on *Water Governance: the Public-Private Debate,* organized by Centre National de la Recherche Scientifique and Center for Sustainability of semi-Arid Hydrology and Riparian Areas, University of Arizona, 4 February 2009.

Scott, C.A.,2008. The United States – Mexico Transboundary Aquifer Assessment Program. *Water Resources Research Center Seminar Series, University of Arizona,* 8 December 2008.

Scott, C.A. 2008. Session chair: H42 Adaptation and Mitigation under Climate Change and Uncertainty. *American Geophysical Union Fall Meeting*, San Francisco, 15-19 Dec. 2008.

Scott, C.A. 2008. Cactus, riparian habitat, and turf grass: water budget and policy implications of vegetation change under urban heat island and effluent irrigation in the southwest U.S. *American Geophysical Union Fall Meeting*, San Francisco, 15-19 Dec. 2008.

Scott, C.A. 2008. Building shared vision: assessment of transboundary aquifers along the United States – Mexico border. *International Conference on Water Scarcity, Global Changes, and Groundwater: Management Responses*, University of California – Irvine, UNESCO, USGS, 1-5 December 2008.

Scott, C.A. 2008. Groundwater rights in Mexican agriculture: spatial distribution and social and economic determinants. *Association of American Geographers Annual Meeting,* Boston, 19 April 2008.

Scott, C. A., R. G. Varady, G. Garfin, M. Wilder, N. Pineda, M. Montero. 2008. Organizers, Stakeholder Workshop: Information Flows and Policy: Use of Climate Diagnostics and Cyclone Prediction for Adaptive Water-Resources Management Under Climatic Uncertainty in Western North America. Inter-American Institute for Global Change Research. Hermosillo, Mexico. 7 Nov. 2008.

Scott, C.A., 2008. Adaptive water resources management under climatic uncertainty in western North America (and member of workshop organizing committee). *Regional Climate Forum for Northwest Mexico and the Southwest United States* (Centro de Investigación Científica y de Educación Superior de Ensenada and NOAA), Ensenada, Baja California, Mexico, 10-11 April 2008.

Scott, C.A. 2007. Energy boom and groundwater bust: Mexico's water-energy nexus with implications for the U.S. border region. *First Western Forum on Energy and Water Sustainability,* Bren School of Environmental Science & Management, Univ. of California, Santa Barbara, 22 March 2007.

Scott, C.A., 2007. The water-energy nexus in Mexico: groundwater sustainability along the border with the United States. *Departmental Seminar Series (Hydrology & Water Resources), University of Arizona,* 21 February 2007.

Scott, C.A. 2007. Water and energy management challenges on the Arizona-Mexico border. *Southwest Hydrology and Arizona Hydrological Society Regional Water Symposium*, Tucson, 31 August 2007.

Scott, C.A., Session chair: Coupled water and energy demand in the Southwest and U.S.-Mexico border region. *Southwest Hydrology and Arizona Hydrological Society Regional Water Symposium*, Tucson, 31 August 2007.

Varady, R. G., M. Wilder, C. A. Scott, N. Pineda, B J. Morehouse, and G. Garfin. 2009. Institutions and Societal Impacts of Climate in the Arizona-Sonora Portion of the U.S.-Mexico Border Region. Presented (by M. Wilder) at Open Meeting of the International Human Dimensions Program (IHDP). Bonn, Germany. 26-30 April.

Varady, R. G., M. Wilder, C. A. Scott, G. Garfin, N. Pineda, B. Morehouse, A. Coles, J. McEvoy, K. Sammler. 2009. Climate, Society, and Information Flows in the U.S.-Mexico Border Region. Poster to be presented at the International Alliance of Research Universities: International Scientific Congress on Climate Change. Copenhagen, Denmark. 10-12 March.

Varady, R.G. 2009. Member of panel on "Challenges posed by climate change and drought and their impacts on water availability and society in North America." Workshop on Climate-Related Water Constraints and Their Implications for Relations Across North American Boundaries. México City, D.F. 5-6 March 5-6.

Varady, R.G., G. Garfin, B. Morehouse, and M. Wilder. 2007. Institutions and societal impacts of climate in the Lower Colorado and San Pedro Basins of the U.S.-Mexico Border region. Presented at AGU Joint Assembly. Acapulco, Mexico. 25 May.

Wilder, M. 2009. Communities, conservation and climate change: New geographies of climate change governance in the binational Colorado Delta Region. Paper to be presented at International Human Dimensions of Global Change (IHDP) Open Meeting, Bonn, Germany April 26-30 (juried selection of papers). With **R. Díaz**.

Wilder, M. 2009. Water, cities, and peri-urban vulnerabilities in Northwest Mexico. Association of the American Geographers Annual Meeting, Las Vegas, Nevada, March. With **R. Díaz**.

Wilder, M. 2008. Inter-American Institute on Global Change Research (IAI) Stakeholders' Workshop, November 7. Una Sobre-Vista de los Proyectos NOAA-SARP y CLIMAS.

Wilder, M. 2008. Sobre agua, ciudades y gestion adaptiva. Universidad de Sonora, Hermosillo, Sonora, Mexico. November 7. Participant and presenter.

Wilder, M. 2008. Overview of NOAA-SARP and CLIMAS projects on water, cities, and adaptive management. Institute for the Study of Planet Earth and Udall Center for Studies in Public Policy, University of Arizona, September 26. Principal organizer and presenter.

Wilder, M. 2008. Political and economic apertures: The shifting state-society relationship and national water policy transition in Mexico. Invited paper for International Water Transitions workshop, University of Amsterdam, Amsterdam, The Netherlands, July 3 and 4.

Wilder, M. 2008. Promises under construction: The evolving water governance paradigm and the case of northern Mexico. Invited participant at the Rosenberg International Forum for Water Policy, Zaragoza, Spain, June 23-28.

Wilder, M. 2008. How does the public fit in? Climate change, adaptation and social stakeholders in the Southwest US and Northwest Mexico. Guest lecture, Department of Political Science, University of Redlands, Redlands, California, May 16.

Wilder, M. 2008. New geographies of environmental governance: Communities, conservation and climate change in the Colorado Delta and Border Region. Spaces and Society Lecture Series, Department of Political Science, University of Redlands, Redlands, California, May 15.

Wilder, M. 2008. New geographies of environmental governance: Communities, conservation and climate change in the Colorado Delta and Border Region. Association of the American Geographers Annual Meeting, Boston, Massachusetts, April 17.

Wilder, M. 2008. The environment for water: 21st-Century transitions in Mexican water policy and implications for Sonora. Rocky Mountain Council on Latin American Studies (RMCLAS) 2008 Meeting, Flagstaff, Arizona, April 11.

Wilder, M. 2008. Transboundary water: Problems and challenges. Presented to Mexican Migration Scholarship Meeting, Consortium of North American Higher Education (CONAHEC), University of Arizona, April 9.

Wilder, M. 2008. Water governance in Mexico. Presented to International Water History Association (IWHA) Board, Tucson, Arizona, March 19.

Wilder, M. 2008. Communities, conservation, and climate change: New geographies of environmental governance in the binational Colorado Delta Region. Department of Geography and Regional Development Colloquium, University of Arizona, February.

Wilder, M., R.G. Varady, N. Pineda, A. Browning-Aiken, R. Díaz, G. Garfin. 2007. New water management institutions in Mexico's 'New Culture of Water': Emerging opportunities and challenges for effective use of climate knowledge and climate science. Presented at AGU Joint Assembly. Acapulco, Mexico. 23 May.

D. Discussion of any significant deviations from proposed workplan (e.g., shift in priorities following consultation with program manager, delayed fieldwork due to late arrival of funds, obstacles encountered during the course of the project that have impacted outcome delivery). *(Limit to one paragraph)*

We do not anticipate any significant deviations from the proposed workplan.

E. Where appropriate, describe the climate information products and forecasts considered in your project (both NOAA and non-NOAA); identify any specific feedback on the NOAA products that might be helpful for improvement. (bulleted response)

Our research team has developed a bilingual, binational climate outlook product. We are field testing the outlook with stakeholders in Arizona and Sonora to improve the utility of the product and to enhance access and use of climate information. The climate outlook produced by this project is distinct from the existing Regional Integrated Sciences and Assessments (RISA) products in the following ways: (1) it possesses a geographic scope centered on the Arizona-Sonora region; (2) it taps explicitly North American Monsoon research cultivated from the multi-agency North American Monsoon Experiment (NAME) and other climate research results to raise public climate awareness; (3) there is collaborative production of climate, institutional and sustainability information based upon binational, cooperative science-sharing and stakeholder partnerships; and (4) it is bilingual, published in English and Spanish to reach a more diverse set of stakeholders within both the United States and Mexico. We anticipate that the advancement of this new product is stimulating the production and dissemination of new stakeholder-informed climate knowledge to improve long-term, regional adaptive water management and climate sensitive decisionmaking.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS ATTACHMENTS TO YOUR REPORT

A. One PowerPoint slide depicting the overall project framework/approach/results to date
B. If appropriate, additional graphic(s) or presentation(s) depicting any key research results thus far
C. Photographs (if easy to obtain) from fieldwork to depict study information (if applicable).

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

http://udallcenter.arizona.edu/sarp/

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES.

Leveraged funds
The NOAA-SARP Moving Forward grant has permitted the team to build synergies with the following leveraged awards:

2007-12 CLIMAS Integrating Climate Science for Decision-Support, Mitigating Risk and Promoting Resilience: Climate Assessment for the Southwest. NOAA Climate Program Office ($4,000,000 over 5 years). (J. Overpeck - PI; G. Garfin, M. Wilder, B. Morehouse – co-PIs). NOAA Climate Program Office.

2007-09 Information Flows and Policy: Use of Climate Diagnostics and Cyclone Prediction for Adaptive Water-Resources Management Under Climatic Uncertainty in Western North America (R. Varady – PI; C.A. Scott – deputy-PI; G.M. Garfin, N. Pineda, M. Montero – co-PIs). $147,286, Inter-American Institute for Global Change Research.

2007-08 Geospatial Analysis of Urban Thermal Gradients: Application to Tucson Arizona's Projected Water Demand (C.A. Scott – PI; S. Yool, A. Comrie – co-PIs). $12,000, United States Geological Survey 104B administered by University of Arizona Water Resources Research Center.

2007 Coupled Water and Energy Demand in the Arizona-Sonora Border Region: Groundwater Pumping, Municipal Water Services, and Electrical Power Interactions (C.A. Scott – PI, R. Varady – co-PI). $10,000, Arizona Water Institute.

2007 Rural and Environmental Water Gradients under Rapid Urban Expansion in Water-Scarce Basins (C.A. Scott – PI). $17,000, International Water Management Institute.

2008 United States – Mexico Transboundary Aquifer Assessment Program (S. Megdal – PI, C.A. Scott, J. Callegary – co-PIs). $333,000, United States Geological Survey.

2008 Border-Area Climate Change Impacts & Water Sector Adaptation Workshop (G. Garfin - PI). $13,000, California Department of Water Resources.

2008-09 Water and Energy Sustainability with Rapid Growth in the Arizona-Sonora Border Region (C.A. Scott – PI, M. Pasqualetti – co-PI). $50,000, Arizona Water Institute.

2008-09 Climate-Related Water Constraints and Their Implications for Relations Across International Boundaries: The North American Experience – The Climate and Hydrology Academic Network for Governance and the Environment (CHANGE). (G. Garfin - PI, V. Magana, R. Stewart - co-PIs). $10, 300, Embassy of Canada; $5,000, NIDIS; $3,000, Drought Research Initiative (Canada); $7,000 Agriculture and Agri-Food Canada; $3,000 Instituto Nacional de Ecologia (Mexico) 11

2009 Water Reuse to Offset Growth-Driven Water Scarcity in the Southwest: From Supply Augmentation to Substitution (C.A. Scott – PI; R. Varady, A. Browning-Aiken – co-PIs). $99,894 pending, WateReuse Foundation.

2002-07 Wilder, Margaret. Co- Principal Investigator, National Oceanic and Atmospheric Administration (NOAA), 2002-2007, Jonathan Overpeck, Institute for the Study of Planet Earth, Principal Investigator, "Variability, Social Vulnerability, and Public Policy in the Southwestern United States "(Climate Assessment of the Southwest, CLIMAS), University of Arizona, Tucson, Arizona; Total award amount: $5,910,447. Wilder percentage: 8.37 %

2003-06 Wilder, Margaret. Co-Principal Investigator, National Oceanic and Atmospheric Association (NOAA) Office of Global Programs (OGP), 2003-2006, Robert G. Varady, Principal Investigator. "Use of Climate-Information Products by Water Managers and Other Stakeholders in Two GCIP/GAPP Watersheds in Arizona/Sonora and Oklahoma." Total award: $236,000. Wilder amount: $44,217.

2009 In-kind contribution from University of Arizona's Institute for the Study of Planet Earth (ISPE). $3,000 for staff time and graphic production of the Binational Climate Summary. (G. Garfin)

2009 In-kind contribution from University of Arizona's Institute for the Study of Planet Earth (ISPE). $1,400 for staff time for the contributions towards the production of the 2009 Border Governors Conference planning and final report.

2008 Travel funding for two graduate student research assistants (J. McEvoy and A. Coles) to attend the joint International American Institute (IAI) – National Center Atmospheric Research (NCAR) colloquium on Seasonality and Water Resources in the Western Hemisphere in Mendoza, Argentina (10/06/08-10/17/08) ($3,000/participant). Total award: $6,000.

2008 The Foro Climatico Regional (Regional Climate Forum) for Northwest Mexico and the Southwest United States, April 10-11, at CICESE, Ensenada, Baja California. The Forum included participants from Mexico and the U.S. The Forum leveraged funds from the SARP project and contributed to building collaboration between U.S. and Mexican scientists in the region, and also contributed to the summer 2008 Binational Climate Summary.